

A photograph of medical professionals in a clinical setting, wearing full personal protective equipment (PPE) including white gowns, blue bouffant hoods, face shields, and yellow respirators. They are attending to a patient lying on a gurney. The scene is brightly lit, and the background shows other medical equipment and staff. A white diagonal graphic element separates the top right corner from the rest of the image.

**10<sup>th</sup> Edition  
Update**

**ATLS®**

**Advanced Trauma Life Support**



# **Initial Assessment**

# **Initial Assessment**

- **1 litre of fluid, judicious approach**
- **Focus on massive transfusion protocols**
- **Tranexamic acid**
- **Coagulopathy**
- **Canadian C Spine Rule**
- **Trauma team**

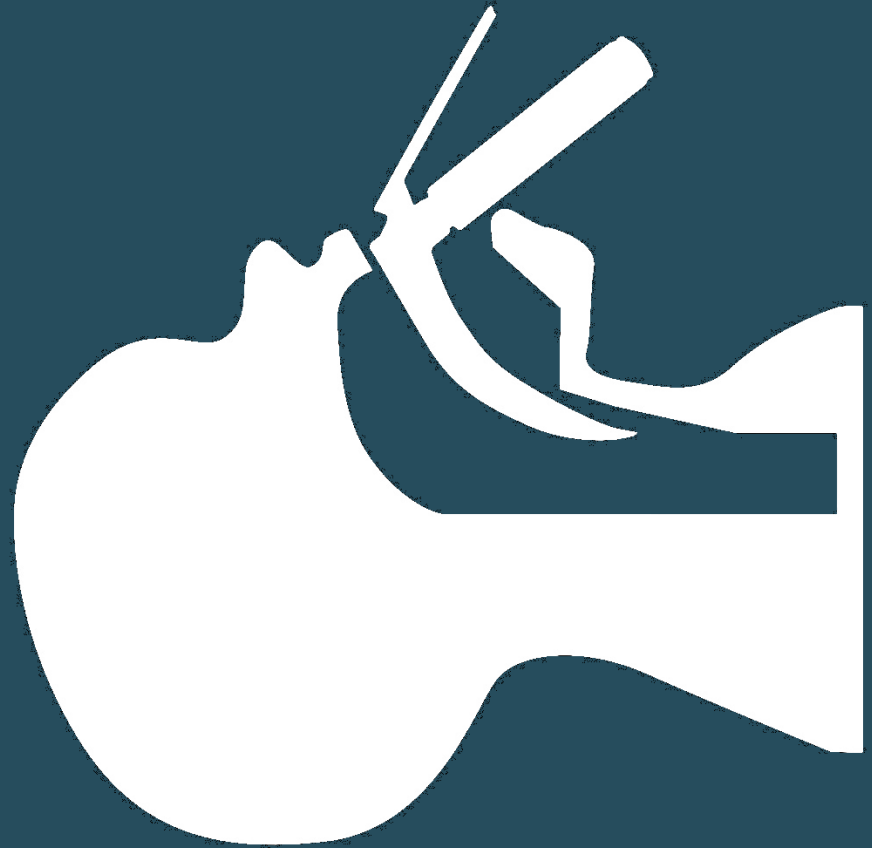
# One liter of fluid, judicious approach

A bolus of isotonic solution **1 L for adults** and **20 mL/kg for pediatric < 40 kg** may be administered judiciously, as aggressive resuscitation before control of bleeding has been demonstrated to increase mortality and morbidity.

If a patient is unresponsive to initial crystalloid therapy, he should receive a blood transfusion.

Aggressive and continued volume resuscitation is not a substitute for definitive control of hemorrhage.

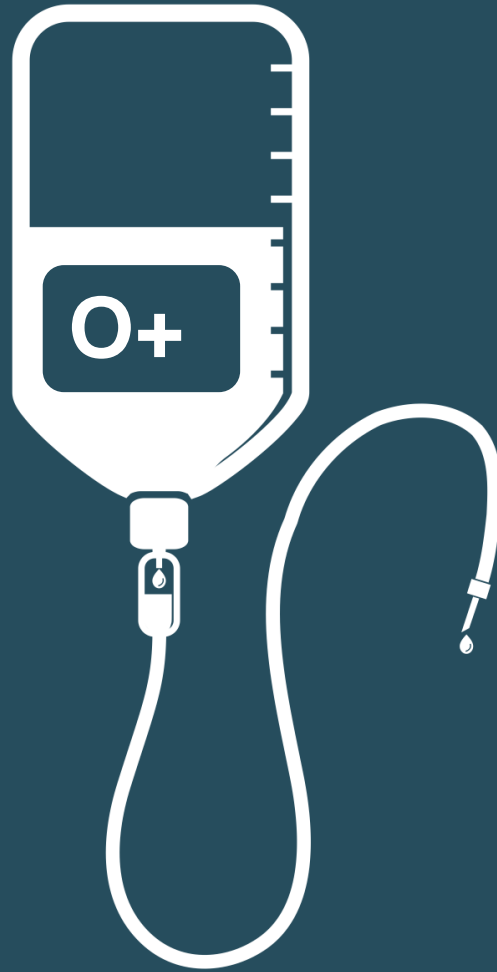
# **Airway and Ventilation**



# **Airway and Ventilation**

- **RSI changed to Drug Assisted Intubation**
- **Video-laryngoscopy**
- **Trauma team**

# Shock



# Shock

- **Class of haemorrhage table amended: Base excess**
- **Early use of blood and blood products**
- **Management of coagulopathy**
- **Tranexamic acid**
- **Trauma team**



# ATLS classification of hypovolemic shock

TABLE 3-1 SIGNS AND SYMPTOMS OF HEMORRHAGE BY CLASS

PARAMETER	CLASS I	CLASS II (MILD)	CLASS III (MODERATE)	CLASS IV (SEVERE)
Approximate blood loss	<15%	15–30%	31–40%	>40%
Heart rate	↔	↔/↑	↑	↑/↑↑
Blood pressure	↔	↔	↔/↓	↓
Pulse pressure	↔	↓	↓	↓
Respiratory rate	↔	↔	↔/↑	↑
Urine output	↔	↔	↓	↓↓
Glasgow Coma Scale score	↔	↔	↓	↓
Base deficit*	0 to –2 mEq/L	–2 to –6 mEq/L	–6 to –10 mEq/L	–10 mEq/L or less
Need for blood products	Monitor	Possible	Yes	Massive Transfusion

# **Early use of blood and blood products**

Early resuscitation with blood and blood products must be considered in patients with evidence of class III and IV hemorrhage.

Early administration of blood products at a low ratio of packed red blood cells to plasma and platelets can prevent the development of coagulopathy and thrombocytopenia.

# Management of coagulopathy

Uncontrolled blood loss can occur in patients taking antiplatelet or anticoagulant medications.

## Prevention

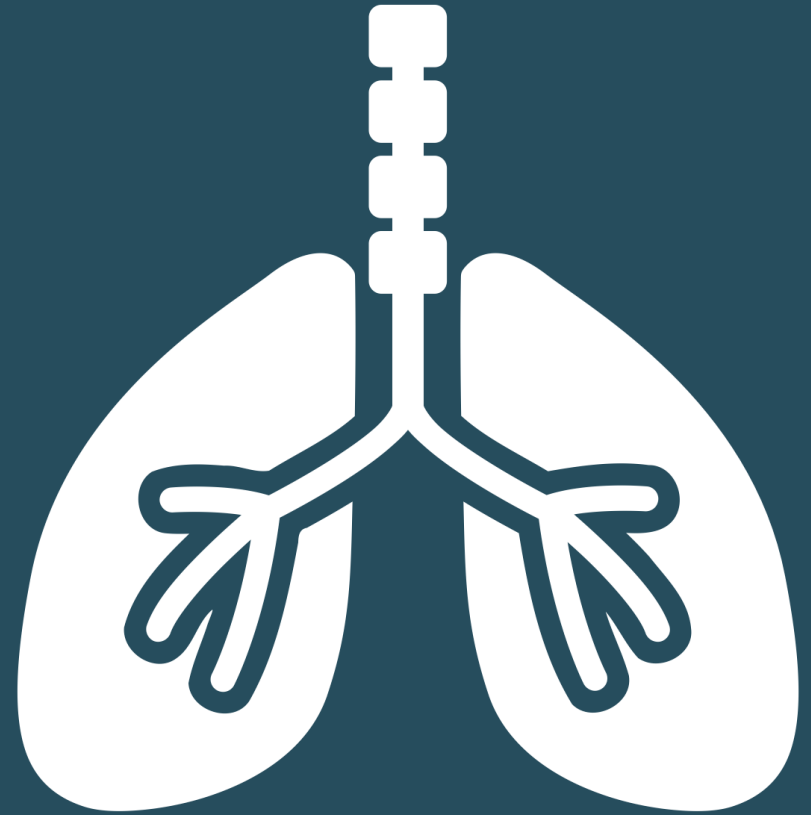
- Obtain medication list as soon as possible.
- Administer reversal agents as soon as possible.
- Where available, monitor coagulation with thromboelastography (TEG) or rotational thromboelastometry (ROTEM).
- Consider administering platelet transfusion, even with normal platelet count.

# Tranexamic acid (TXA)

European and American military studies demonstrate improved survival when **TXA** is administered **over 10 minutes within 3 hours of injury**.

When bolused in the field, follow up **infusion TAX 1 gram over 8 hours** in the hospital.

# **Thoracic Trauma**



# Thoracic Trauma

- **Life Threatening Injuries**
  - Flail chest out
  - Tracheobronchial injury now in
- **Tension pneumothorax**
  - Needle thoracocentesis
    - 5<sup>th</sup> ICS MAL for adult
    - UNCHANGED 2<sup>nd</sup> ICS for child
  - 28-32 Fr chest drain for hemothorax (not 36-40 Fr)
- **Algorithm for circulatory arrest approach**
- **Aortic rupture management with Beta Blocker**
- **Trauma team**

# **Life-threatening injuries during primary survey**

## **Airway**

- Airway Obstruction
- Tracheobronchial Tree Injury

## **Breathing**

- Tension Pneumothorax
- Open Pneumothorax

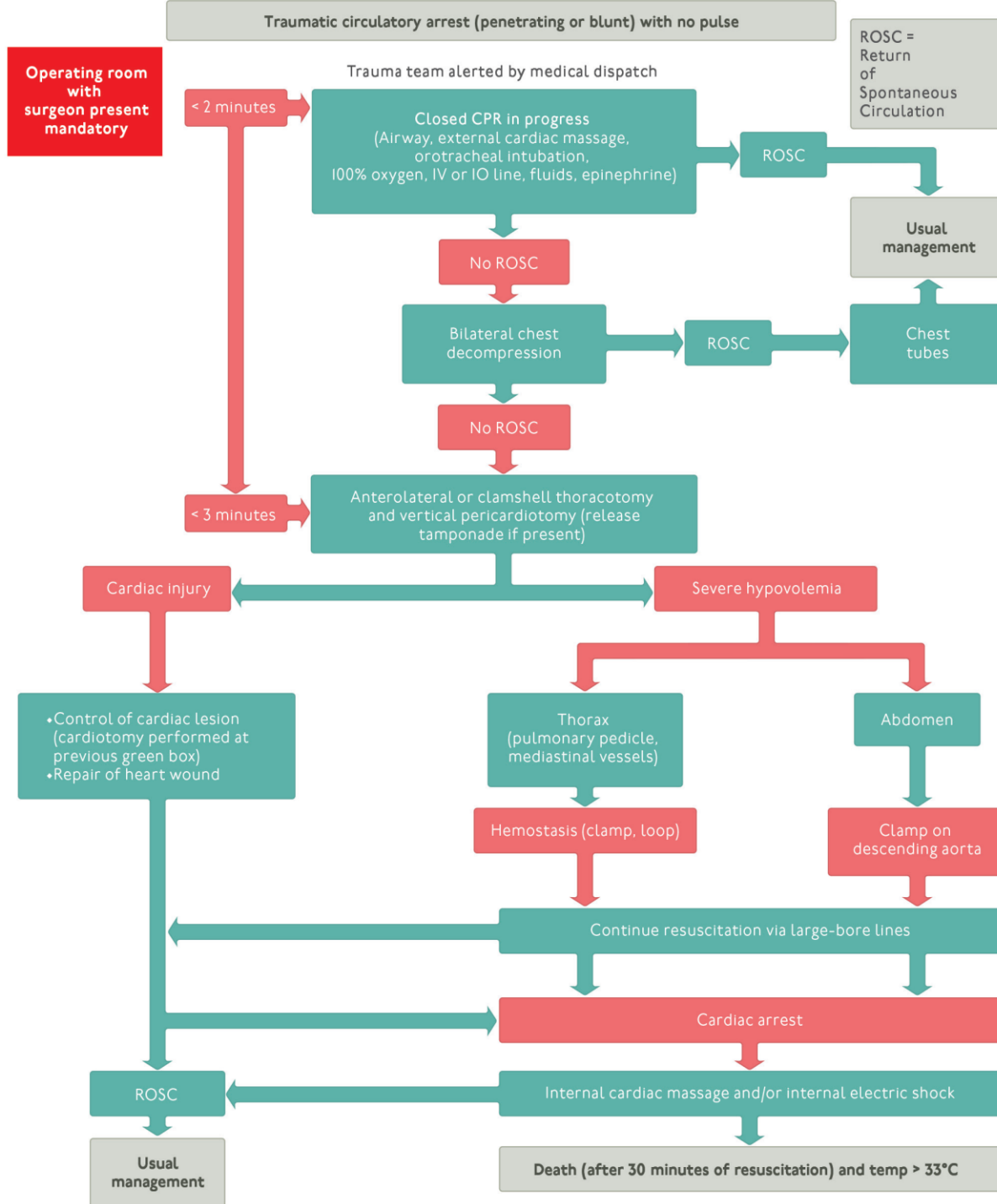
## **Circulation**

- Massive Hemothorax
- Cardiac Tamponade
- Traumatic Circulatory Arrest

# Tension pneumothorax

- When ultrasound is available, tension pneumothorax can be diagnosed using an **extended FAST (eFAST)**: seashore, bar code, or stratosphere sign in M mode.
- **Needle decompression:**  
Recent evidence supports placing the large, over-the-needle catheter at the fifth interspace, slightly anterior to the midaxillary line
- 28-32 Fr chest tube for hemothorax (not 36-40Fr)





## Algorithm for management of traumatic circulatory arrest.

ECM = external cardiac massage;  
OTI = orotracheal intubation;  
IVL = intravenous line;  
IOL = intraosseous line.

# Aortic rupture management with beta blocker

If no contraindications exist, heart rate control with a short-acting beta blocker (esmolol) to a **goal heart rate < 80 bpm** and blood pressure control with a **goal MAP 60-70 mmHg** is recommended.

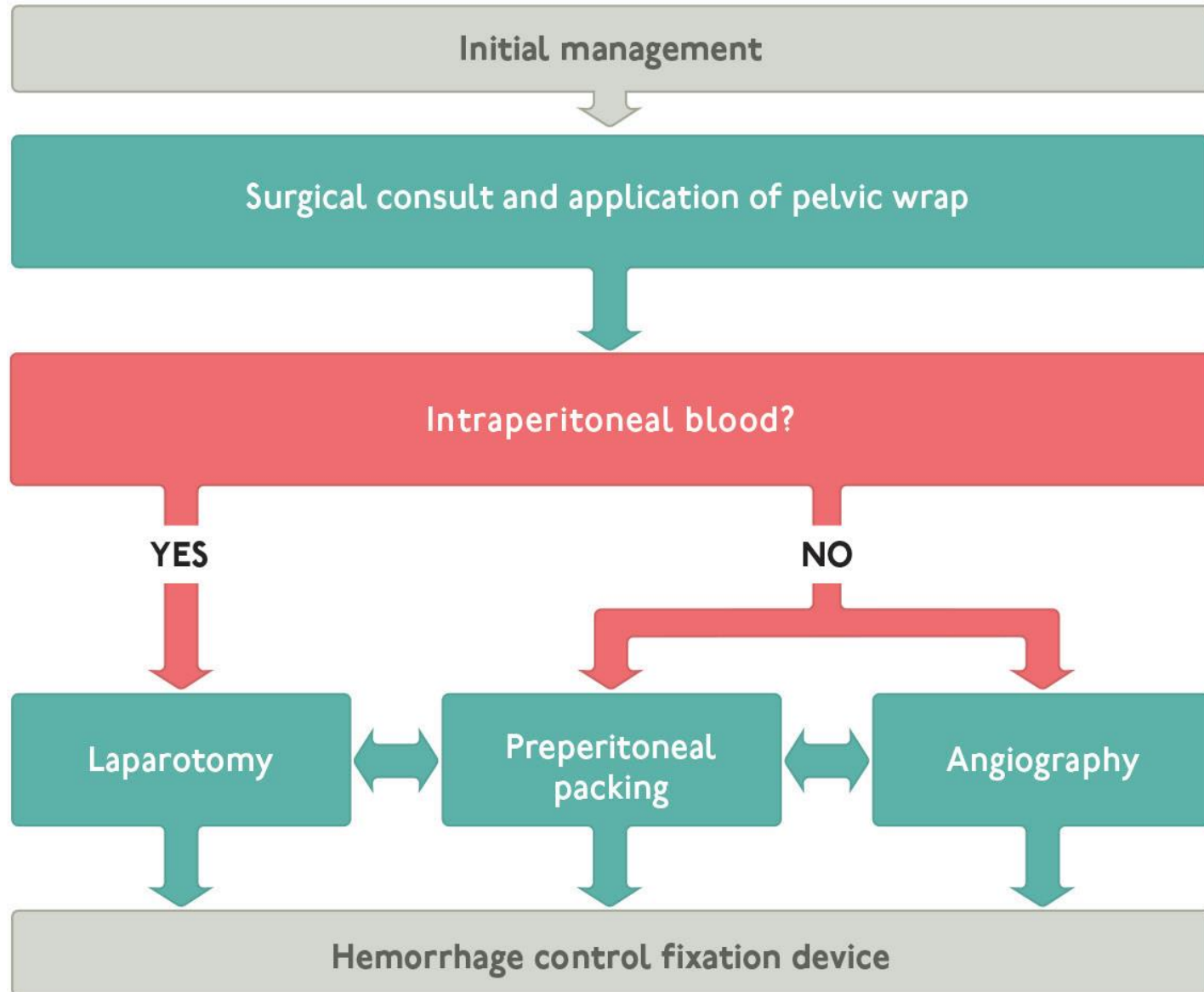
# **Abdominal and Pelvic Trauma**



# **Abdominal and Pelvic Trauma**

- **Palpation of prostate gland no longer recommended for urethral injury**
- **Flow chart for pelvic fracture with hemorrhage amended**
- **Trauma team**

# Pelvic fractures and hemorrhagic shock management algorithm



# **Head Trauma**



# Head Trauma

- **Detailed guidance on SBP management**
- **Classification – ‘mild’ head trauma**
- **Anticoagulation reversal guidance**
- **Seizure prophylaxis**
- **Trauma team**

# Detailed guidance on SBP management

Maintain **SBP at  $\geq 100$  mmHg** for patients 50-69 years or at  $\geq 110$  mmHg for patients 15-49 years or older than 70 years; this may decrease mortality and improve outcomes (III).



# Goals of treatment of brain injury

## Clinical Parameters

- Systolic BP  $\geq 100$  mmHg
- Temperature 36–38°C

## Monitoring Parameters

- CPP  $\geq 60$  mm Hg\*
- ICP 5–15 mm Hg\*
- PbtO<sub>2</sub>  $\geq 15$  mm Hg\*
- Pulse oximetry  $\geq 95\%$

## Laboratory Parameters

- Glucose 80–180 mg/dL
- Hemoglobin  $\geq 7$  g/dl
- INR  $\leq 1.4$
- Na 135–145 meq/dL
- PaO<sub>2</sub>  $\geq 100$  mmHg
- PaCO<sub>2</sub> 35–45 mmHg
- pH 7.35–7.45
- Platelets  $\geq 75 \times 10^3/\text{mm}^3$

\*Unlikely to be available in the ED or in low-resource settings

Data from ACS TQIP Best Practices in the Management of Traumatic Brain Injury.

ACS Committee on Trauma, January 2015.

# Anticoagulation reversal guidance

TABLE 6-6 ANTICOAGULATION REVERSAL

ANTICOAGULANT	TREATMENT	COMMENTS
Antiplatelets (e.g., aspirin, plavix)	Platelets	May need to repeat; consider desmopressin acetate (Deamino-Delta-D-Arginine Vasopressin)
Coumadin (warfarin)	FFP, Vitamin K, prothrombin complex concentrate (Kcentra), Factor VIIa	Normalize INR; avoid fluid overload in elderly patients and patients who sustained cardiac injury
Heparin	Protamine sulfate	Monitor PTT
Low molecular weight heparin, e.g., Lovenox (enoxaparin)	Protamine sulfate	N/A
Direct thrombin inhibitors dabigatran etexilate (Pradaxa)	idarucizumab (Praxbind)	May benefit from prothrombin complex concentrate (e.g., Kcentra)
Xarelto (rivaroxaban)	N/A	May benefit from prothrombin complex concentrate (e.g., Kcentra)

# Seizure prophylaxis

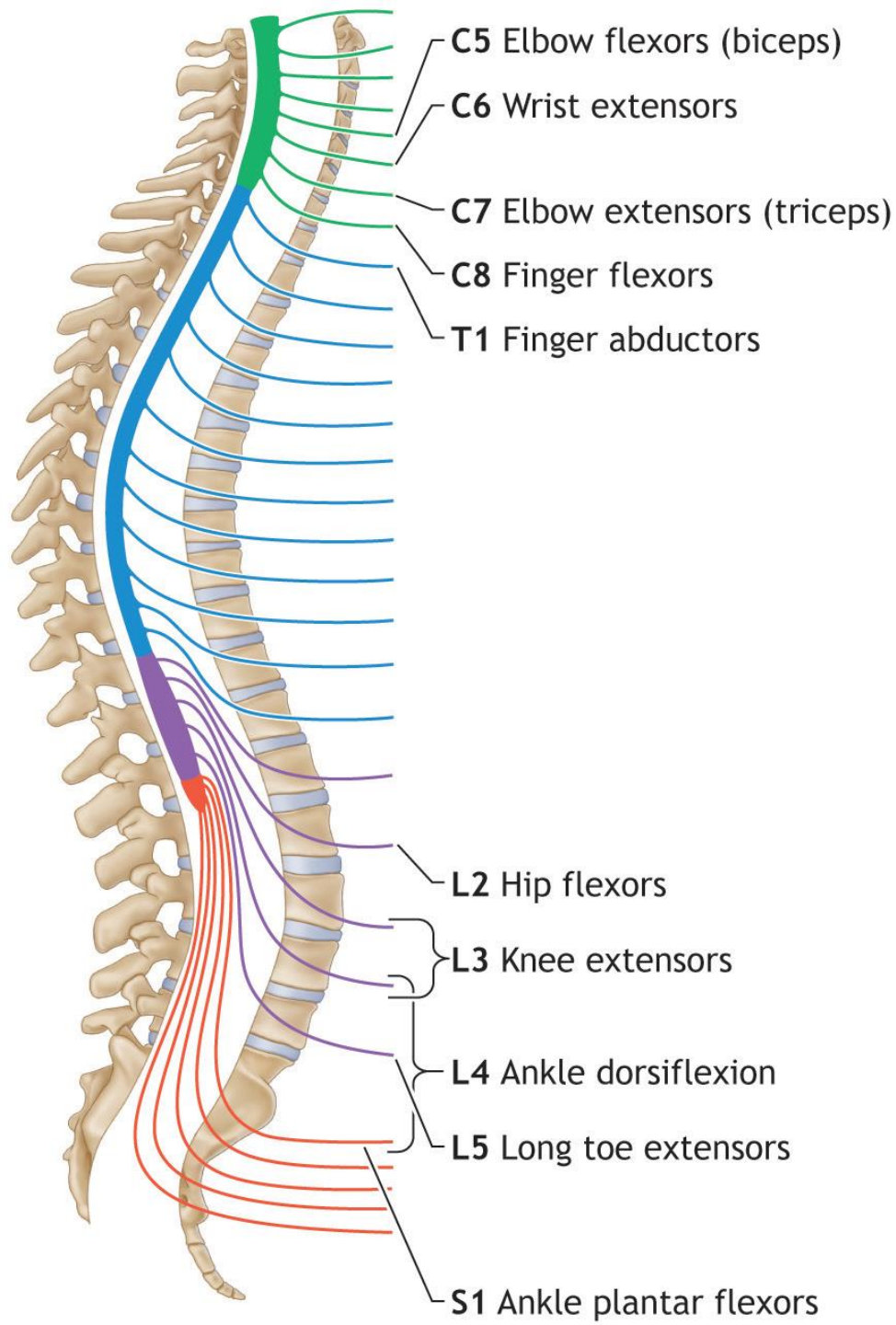
Prophylactic use of phenytoin (Dilantin) or valproate (Depakote) is not recommended for preventing late posttraumatic seizures (PTS). Phenytoin is recommended to decrease the incidence of early PTS (within 7 days of injury), when the overall benefit is felt to outweigh the complications associated with such treatment. However, early PTS has not been associated with worse outcomes (IIA).

# **Spine and Spinal Cord Trauma**



# **Spine and Spinal Cord Trauma**

- **C-spine protection changed to 'Restriction of spinal motion'**
- **New myotome diagram**
- **Canadian C-Spine Rule (CCR) and NEXUS Criteria**
- **Trauma team**



**Key Myotomes.**  
**Myotomes are used to evaluate the level of motor function**

## LEFT

☐ (DAP) Deep Anal Pressure  
(Yes/No)

	<i>R</i>	<i>L</i>
<i>SENSORY</i>		
<i>MOTOR</i>		



## Muscle Function Grading

- 0 = total paralysis  
 1 = palpable or visible contraction  
 2 = active movement, full range of motion (ROM) with gravity eliminated  
 3 = active movement, full ROM against gravity  
 4 = active movement, full ROM against gravity and moderate resistance in a muscle specific position  
 5 = (normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person  
 5\* = (normal) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors (i.e. pain, disuse) were not present  
 NT = not testable (i.e. due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal ROM)

## Sensory Grading

- 0 = Absent  
 1 = Altered, either decreased/impaired sensation or hypersensitivity  
 2 = Normal  
 NT = Not testable

## When to Test Non-Key Muscles:

In a patient with an apparent AIS B classification, non-key muscle functions more than 3 levels below the motor level on each side should be tested to most accurately classify the injury (differentiate between AIS B and C).

Movement	Root level
<b>Shoulder:</b> Flexion, extension, abduction, adduction, internal and external rotation	C5
<b>Elbow:</b> Supination	
<b>Elbow:</b> Pronation	C6
<b>Wrist:</b> Flexion	
<b>Finger:</b> Flexion at proximal joint, extension.	C7
<b>Thumb:</b> Flexion, extension and abduction in plane of thumb	
<b>Finger:</b> Flexion at MCP joint	C8
<b>Thumb:</b> Opposition, adduction and abduction perpendicular to palm	
<b>Finger:</b> Abduction of the index finger	T1
<b>Hip:</b> Adduction	L2
<b>Hip:</b> External rotation	L3
<b>Hip:</b> Extension, abduction, internal rotation	L4
<b>Knee:</b> Flexion	
<b>Ankle:</b> Inversion and eversion	
<b>Toe:</b> MP and IP extension	
<b>Hallux and Toe:</b> DIP and PIP flexion and abduction	L5
<b>Hallux:</b> Adduction	S1

## ASIA Impairment Scale (AIS)

**A = Complete.** No sensory or motor function is preserved in the sacral segments S4-5.

**B = Sensory Incomplete.** Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.

**C = Motor Incomplete.** Motor function is preserved at the most caudal sacral segments for voluntary anal contraction (VAC) OR the patient meets the criteria for sensory incomplete status (sensory function preserved at the most caudal sacral segments (S4-S5) by LT, PP or DAP), and has some sparing of motor function more than three levels below the ipsilateral motor level on either side of the body.  
 (This includes key or non-key muscle functions to determine motor incomplete status.) For AIS C – less than half of key muscle functions below the single NLI have a muscle grade  $\geq 3$ .

**D = Motor Incomplete.** Motor incomplete status as defined above, with at least half (half or more) of key muscle functions below the single NLI having a muscle grade  $\geq 3$ .

**E = Normal.** If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade.

**Using ND:** To document the sensory, motor and NLI levels, the ASIA Impairment Scale grade, and/or the zone of partial preservation (ZPP) when they are unable to be determined based on the examination results.

**ASIA**  
 AMERICAN SPINAL INJURY ASSOCIATION  
 INTERNATIONAL STANDARDS FOR NEUROLOGICAL  
 CLASSIFICATION OF SPINAL CORD INJURY

**ISCOS**  
 INTERNATIONAL SPINAL CORD SOCIETY

The following order is recommended for determining the classification of individuals with SCI.

### 1. Determine sensory levels for right and left sides.

The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.

### 2. Determine motor levels for right and left sides.

Defined by the lowest key muscle function that has a grade of at least 3 (on supine testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).

Note: in regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal.

### 3. Determine the neurological level of injury (NLI)

This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively.

The NLI is the most cephalad of the sensory and motor levels determined in steps 1 and 2.

### 4. Determine whether the injury is Complete or Incomplete.

(i.e. absence or presence of sacral sparing)

If voluntary anal contraction = **No** AND all S4-5 sensory scores = **0** AND deep anal pressure = **No**, then injury is **Complete**.

Otherwise, injury is **Incomplete**.

### 5. Determine ASIA Impairment Scale (AIS) Grade:

**Is injury Complete?** If YES, AIS=A and can record ZPP (lowest dermatome or myotome on each side with some preservation)

NO

**Is injury Motor Complete?** If YES, AIS=B

NO

(No=voluntary anal contraction OR motor function more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)

Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?

NO

AIS=C

YES

AIS=D

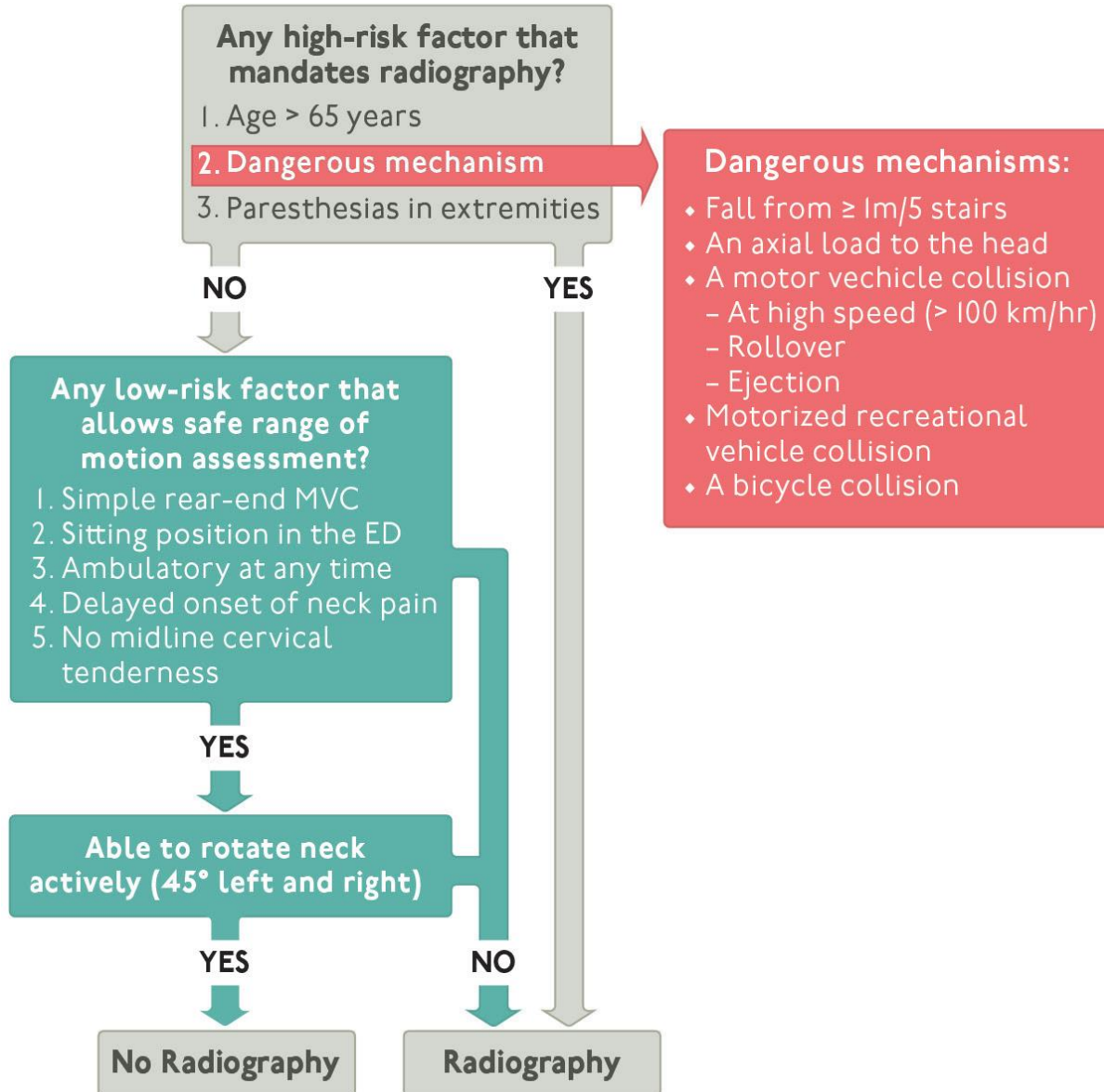
If sensation and motor function is normal in all segments, AIS=E

Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact; the ASIA Impairment Scale does not apply.



## Canadian C-spine Rule (CCR)

For alert (GCS score =15) and stable trauma patients in whom cervical spine injury is a concern:



## National Emergency X-Radiography Utilization Study (NEXUS) Criteria

### Meets ALL low-risk criteria?

1. No posterior midline cervical-spine tenderness and...
2. No evidence of intoxication and...
3. A normal level of alertness and...
4. No focal neurologic deficit and...
5. No painful distracting injuries

**YES**

**No Radiography**

**NO**

**Radiography**

### NEXUS Mnemonic

**N**– Neuro deficit

**E**– EtOH (alcohol)/intoxication

**X**– eXtreme distracting injury(ies)

**U**– Unable to provide history (altered level of consciousness)

**S**– Spinal tenderness (midline)

# **Musculo- Skeletal Trauma**



# **Musculoskeletal Trauma**

- **Weight based IV antibiotic regime**
- **Highlighting risk factor of bilateral femur fractures**
- **Trauma team**

# **Highlighting risk factor of bilateral femur fractures**

Compared with patients with unilateral femur fractures, patients with bilateral femur fractures are at higher risk for significant blood loss, severe associated injuries, pulmonary complications, multiple organ failure, and death.

**TABLE 8-2 INTRAVENOUS ANTIBIOTIC WEIGHT-BASED DOSING GUIDELINES**

	FIRST-GENERATION CEPHALOSPORINS (GRAM-POSITIVE COVERAGE)	IF ANAPHYLACTIC PENICILLIN ALLERGY (INSTEAD OF FIRST- GENERATION CEPHALOSPORIN) CLINDAMYCIN	AMINOGLYCOCIDE (GRAM-NEGATIVE COVERAGE)	PIPERACILLIN/ TAZOBACTAM (BROAD-SPECTRUM GRAM-POSITIVE AND NEGATIVE COVERAGE)
OPEN FRACTURES	CEFAZOLIN		GENTAMICIN	
Wound <1 cm; minimal con- tamination or soft tissue damage	<50 kg: 1 gm Q 8 hr 50–100 kg: 2 gm Q 8 hr >100 kg: 3 gm Q 8 hr	<80 kg: 600 mg Q 8 hr >80 kg: 900 mg Q 8 hr		
Wound 1–10 cm; moderate soft tissue damage; comminution of fracture	<50 kg: 1 gm Q 8 hr 50–100 kg: 2 gm Q 8 hr >100 kg: 3 gm Q 8 hr	<80 kg: 600 mg Q 8 hr >80 kg: 900 mg Q 8 hr		
Severe soft- tissue damage and substantial contamination with associated vascular injury	<50 kg: 1 gm Q 8 hr 50–100 kg: 2 gm Q 8 hr >100 kg: 3 gm Q 8 hr	<80 kg: 600 mg Q 8 hr >80 kg: 900 mg Q 8 hr	Loading dose in ER:  2.5 mg/kg for child (or <50 kg) 5 mg/kg for adult  (i.e., 150-lb pt = 340 mg)	
Farmyard, soil or standing water, irrespective of wound size or severity				3.375 gm Q 6 hr (<100 kg)  4.5 gm Q 6 hr (>100 kg)  **If anaphylactic penicillin allergy consult Infectious Disease Department or Pharmacy

# **Thermal Injuries**



# Thermal Injuries

- **2 ml/kg × weight × % burn adults**
- **3 ml/kg × weight × % burn children**
- **Fluid titrated to urine output**
- **Trauma team**



**TABLE 9-1 BURN RESUSCITATION FLUID RATES AND TARGET URINE OUTPUT BY BURN TYPE AND AGE**

CATEGORY OF BURN	AGE AND WEIGHT	ADJUSTED FLUID RATES	URINE OUTPUT
Flame or Scald	Adults and older children ( $\geq 14$ years old)	2 mL LR x kg x % TBSA	0.5 mL/kg/hr  30–50 mL/hr
	Children ( $< 14$ years old)	3 mL LR x kg x % TBSA	1 mL/kg/hr
	Infants and young children ( $\leq 30$ kg)	3 mL LR x kg x % TBSA  Plus a sugar-containing solution at maintenance rate	1 mL/kg/hr
Electrical Injury	All ages	4 mL LR x kg x % TBSA until urine clears	1–1.5 mL/kg/hr until urine clears

LR, lactated Ringer's solution; TBSA, total body surface area

# **Paediatric Trauma**

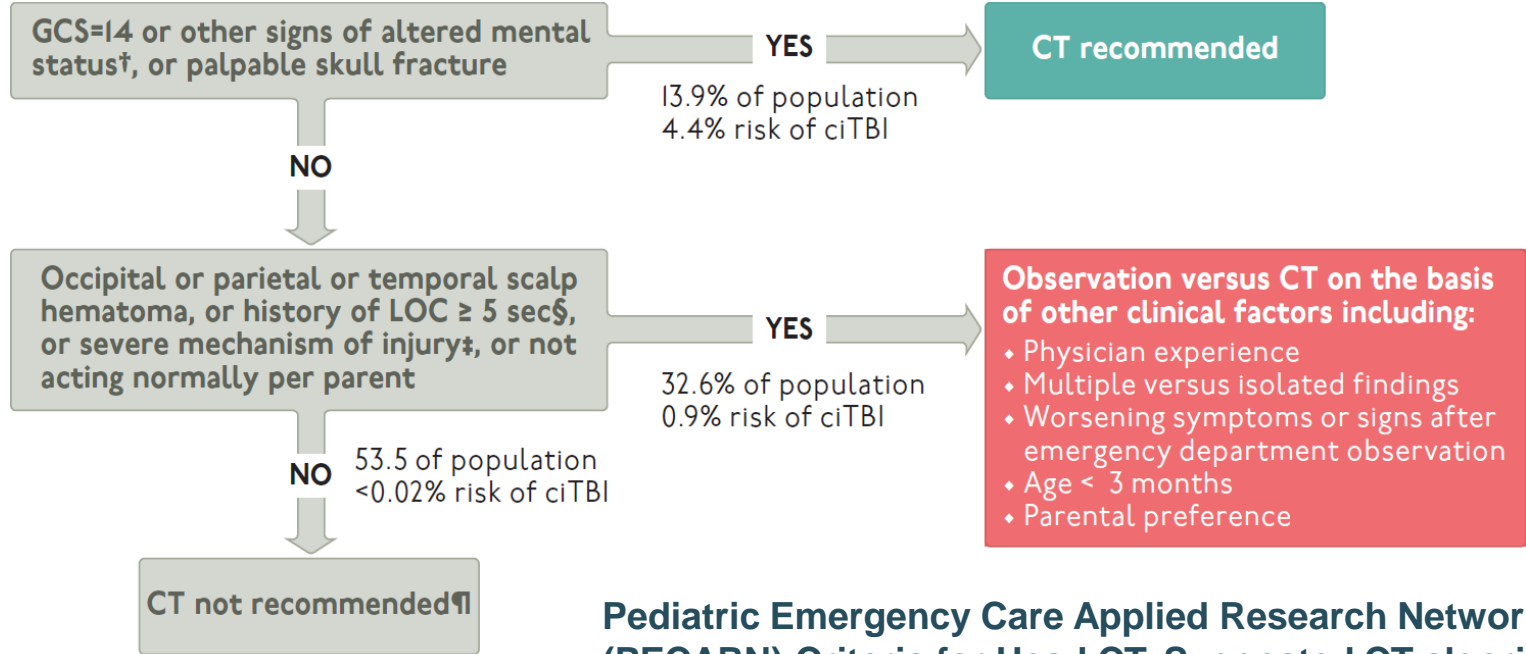


# **Paediatric Trauma**

- **Needle thoracocentesis  
UNCHANGED 2<sup>nd</sup> ICS**
- **Limiting crystalloid resuscitation**
- **Pediatric Emergency Care Applied  
Research Network (PECARN)  
Criteria for Head CT**
- **Trauma team**

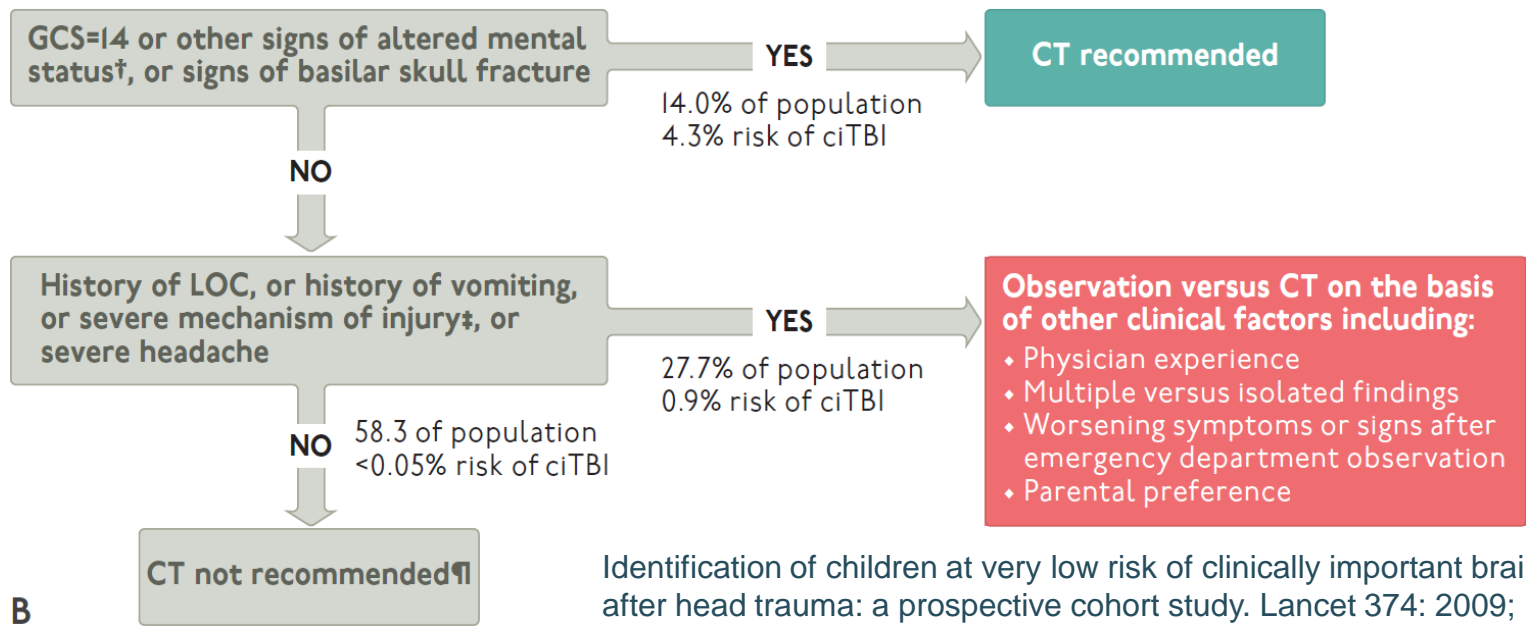
# **Pediatric Mass Transfusion Protocol**

Initial 20 mL/kg bolus of isotonic crystalloid followed by weight-based blood product resuscitation with 10-20 mL/kg of RBC and 10-20 mL/kg of FFP and platelets.



**A**

**Pediatric Emergency Care Applied Research Network (PECARN) Criteria for Head CT. Suggested CT algorithm for children younger than 2 years (A) and for those aged 2 years and older (B) with GCS scores of 14-15 after head trauma.\***



Identification of children at very low risk of clinically important brain injuries after head trauma: a prospective cohort study. Lancet 374: 2009; 1160–1170.)



**Transfer to  
Definitive Care**

# **Transfer to Definitive Care**

- **Specific mention of avoiding CT in primary hospital**
- **SBAR template for communication**
- **Trauma Team**

# **Avoiding CT in primary hospital**

Do not perform diagnostic procedures (e.g., DPL or CT) that do not change the plan of care.

However, procedures that treat or stabilize an immediately life-threatening condition should be rapidly performed.



# ABC-SBAR template for transfer of trauma patients

- **Airway, Breathing, and Circulation** problems identified and interventions performed
- **Situation:** patient name, age, referring facility, referring physician name, reporting nurse name, indication for transfer, IV access site, IV fluid and rate, other interventions completed
- **Background:** event history, AMPLE assessment, blood products, medications given (date and time), imaging performed, splinting
- **Assessment:** vital signs, pertinent physical exam findings, patient response to treatment
- **Recommendation:** transport mode, level of transport care, medication intervention during transport, needed assessments and interventions

# Mobile eLearning



**mATLS™**  
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TENTH EDITION

# 1 INITIAL ASSESSMENT AND MANAGEMENT

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Advanced Trauma Life Support<sup>®</sup>



100+years

AMERICAN COLLEGE OF SURGEONS

*Inspiring Quality:  
Highest Standards, Better Outcomes*



## Other Monitoring Includes:

- Pulse rate
- Blood pressure
- Pulse pressure
- Ventilatory rate
- Oxygen saturation
- Arterial blood gas levels
- Body temperature
- Urinary output

Obtain actual values for these parameters as soon as possible during the primary survey, and then periodically reevaluate them.







## Focused Assessment with Sonography for Trauma

Duration 1:56



